

CLAIMS

We claim:

1. A method for removing metal ions from streams contaminated with metal ions including the step of passing the stream through at least one zone comprising a volumetric mixture of an ion exchange material and an a substantially inert material at a relatively high stream flow rate.
2. The method of claim 1, further comprising the step of passing the stream through a plurality of zones comprising a volumetric mixture of an ion exchange material and an a substantially inert material at a relatively high stream flow rate.
3. The methods of claims 1-2, wherein the volumetric mixture comprises from about 90 to 50 vol% of an ion exchange material and from about 10 to 50 vol% of an a substantially inert material.
4. The methods of claims 1-3, wherein the flow rate is at least about 1.5 to about 5 times the flow rate of a stream flow rate generally used in the industry.
5. The methods of claims 1-4, wherein the stream is an aqueous stream including contaminating metal ion and the resulting stream has metal ion concentrations at or below the concentrations dictated by the current clean water standards
6. A method for closed loop circulation of an aqueous stream with concurrent removal of metal ion contaminants contained in the stream, comprising the steps of:
 - directing an aqueous effluent stream from an outlet of an industrial process contaminated with metal ions to an extraction unit including at least one zone or bed comprising a volumetric mixture of an ion exchange material and an a substantially inert material,
 - passing the effluent stream through the zone or bed at a relatively high stream flow rate to produce a cleaned aqueous stream having metal ion concentrations at or below existing clean water standards, and
 - directing the cleaned stream into an inlet of the industrial process.
7. The method of claim 6, wherein the method is either continuous, semi-continuous, or periodic or batch basis.

8. The methods of claims 6-7, further comprising the step of passing the stream through a plurality of zones comprising a volumetric mixture of an ion exchange material and an a substantially inert material at a relatively high stream flow rate.
9. The methods of claims 6-8, wherein the volumetric mixture comprises from about 90 to 50 vol% of an ion exchange material and from about 10 to 50 vol% of an a substantially inert material.
10. The methods of claims 6-9, wherein the flow rate is at least about 1.5 to about 5 times the flow rate of a stream flow rate generally used in the industry.
11. An apparatus for removing metal ion contaminants from an effluent stream comprising an extraction unit including an inlet and an outlet and at least one bed or zone comprising a volumetric mixture of an ion exchange resin and an inert material.
12. The apparatus of claim 11, further comprising a pump sufficient to increase the volumetric flow rate of the stream.
13. The apparatuses of claims 11-12, further comprising a plurality of zones comprising a volumetric mixture of an ion exchange material and an a substantially inert material at a relatively high stream flow rate.
14. The apparatuses of claims 11-13, wherein the volumetric mixture comprises from about 90 to 50 vol% of an ion exchange material and from about 10 to 50 vol% of an a substantially inert material.
15. The apparatuses of claims 11-14, wherein the flow rate is at least about 1.5 to about 5 times the flow rate of a stream flow rate generally used in the industry.
16. The apparatuses of claims 11-15 wherein the stream is an aqueous stream including contaminating metal ion and the resulting stream has metal ion concentrations at or below the concentrations dictated by the current clean water standards

17. An apparatus for removing metal ion contaminants for a closed loop circulation of aqueous stream, comprising

an industrial application producing an effluent stream contaminated with metal ions and
an extraction unit including at least one zone or bed comprising a volumetric mixture of an ion exchange material and from a substantially inert material, where the metal ion contaminants are removed to a desired low level to produce a clean recycle stream and where the industrial application and the extraction unit are connected by an effluent line so that the effluent stream flows from the industrial application into the extraction unit on a continuous, semi-continuous or periodic basis and a recycle line so that the clean recycle stream flows from the extraction unit into the industrial application.

18. The apparatuses of claim 17, further comprising the step of passing the stream through a plurality of zones comprising a volumetric mixture of an ion exchange material and an a substantially inert material at a relatively high stream flow rate.

19. The apparatuses of claims 17-18, wherein the volumetric mixture comprises from about 90 to 50 vol% of an ion exchange material and from about 10 to 50 vol% of an a substantially inert material.

20. The apparatuses of claims 17-19, wherein the flow rate is at least about 1.5 to about 5 times the flow rate of a stream flow rate generally used in the industry.

21. The apparatuses of claims 17-20, wherein the stream is an aqueous stream including contaminating metal ion and the resulting stream has metal ion concentrations at or below the concentrations dictated by the current clean water standards